

What is claimed is:

1. A method for receiving a signal comprising:

receiving K replicas of the signal, each of the K replicas being received by one of a

5 corresponding K antennas so as to thereby generate K received signal replicas;

processing each of the K received signal replicas using one of N orthogonal sequences,
thereby generating K processed signal replicas, wherein N is less than K ;

orthogonally multiplexing the K processed received signal replicas into a multiplexed
signal provided to a signal processing chain;

10 downconverting, within the signal processing chain, the multiplexed signal into a
baseband multiplexed signal; and

transforming the baseband multiplexed signal into K separate signals wherein each of the
 K separate signals corresponds to one of the K replicas of the signal.

15 2. The method of claim 1 wherein the processing includes:

assigning each of N of the K received signal replicas a corresponding one of the N
orthogonal sequences so as to thereby generate a first composite signal;

scrambling the first composite signal according to a first scrambling sequence so as to
thereby generate a first set of N channel signals;

20 assigning each of M of the K received signal replicas a corresponding one of M
orthogonal sequences so as to thereby generate a second composite signal, wherein the M
orthogonal sequences are a subset of the N orthogonal sequences;

scrambling the second composite signal according to a second scrambling sequence so as
to thereby generate a second set of M channel signals; and

25 combining the first set of N channel signals and the second set of M channel signals so as
to generate the multiplexed signal.

3. The method of claim 2 wherein the transforming includes:

30 removing interference due to the first set of N channel signals from the second set of M
channel signals, thereby generating M interference-reduced signals comprising a subset of the K
separate signals.

4. The method of claim 3 wherein the transforming includes:

removing interference due to the second set of M channel signals from the first set of N channel signals, thereby generating N interference-reduced signals comprising a subset of the K separate signals.

5. The method of claim 3 wherein the removing includes:

despreading the first set of N channel signals so as to generate a set of N despread baseband signals;

synthesizing an interference signal as a function of the set of N despread baseband signals; and

subtracting the interference signal from the baseband multiplexed signal thereby removing interference due to the first set of N channel signals from the second set of M channel signals.

6. The method of claim 5 wherein the synthesizing includes:

passing each of the N despread baseband signals through a corresponding one of N threshold detectors so as to generate an estimated set of N symbol values for the first set of N channel signals;

spreading each of the N symbol values according to a corresponding one of the N orthogonal sequences so as to generate a first baseband composite signal; and

scrambling the first baseband composite signal according to the first scrambling sequence so as to synthesize the interference signal.

7. The method of claim 4 wherein the removing includes:

despreading the first set of N channel signals so as to generate a set of N despread
baseband signals;

despreading the second set of M channels signals so as to generate a set of M despread
5 baseband signals;

subtracting, from each of the N despread baseband signals, an interference signal
synthesized as a function of the M despread baseband signals thereby removing interference due
to the second set of M channel signals from the first set of N channel signals.

10 8. The method of claim 7 wherein the interference signal is synthesized as a function of
estimated symbol values generated from the M despread baseband signals.

9. The method of claim 1 wherein the signal complies with a communication protocol
selected from the group consisting of: orthogonal frequency division multiplexing (OFDM),
15 time division multiple access (TDMA), code division multiple access (CDMA), gaussian
minimum shift keying (GMSK), complementary code keying (CCK), quadrature phase shift
keying (QPSK), frequency shift keying (FSK), phase shift keying (PSK), and quadrature
amplitude modulation (QAM).

20

10. An apparatus for receiving a signal comprising:

K antenna elements, wherein the K antenna elements are arranged to receive one of a corresponding K replicas of the signal and thereby generate K received signal replicas;

a signal processing chain;

5 a first multiplexer configured to receive N of the K received signal replicas and generate a first set of N channel signals, wherein each of the N channel signals is spread according to a corresponding one of N orthogonal sequences and corresponds to one of the N received signal replicas;

10 a second multiplexer configured to receive M of the K received signal replicas and generate a second set of M channel signals, wherein each of the M channel signals is spread according to one of the N orthogonal sequences and corresponds to one of the M received signal replicas;

15 a summing portion coupled between the signal processing chain and the first and second multiplexers, wherein the summing portion is configured to combine the first set of N channel signals and the second set of M channel signals into a multiplexed signal and provide the multiplexed signal to the signal processing chain;

a downconversion module configured to downconvert, within the signal processing chain, the multiplexed signal to a baseband multiplexed signal; and

20 a signal recovery module coupled to the signal processing chain, wherein the signal recovery module is configured to receive the baseband multiplexed signal and provide K separate signals from the baseband multiplexed signal, wherein each of the K separate signals corresponds to one of the K replicas of the signal.

11. The apparatus of claim 10 wherein the first multiplexer includes:

a first spreading module coupled to N of the K antenna elements, wherein the first spreading module is configured to receive N of the K received signal replicas and orthogonally spread each of the N received signal replicas with a corresponding one of the N orthogonal sequences so as to generate a set of N spread signals

a first summing module coupled to the first spreading module wherein the first summing module is configured to combine the set of N spread signals so as to generate a first composite signal; and

a first scrambling portion coupled to the first summing module, wherein the first scrambling portion is configured to generate the first set of N channel signals by scrambling the first composite signal.

12. The apparatus of claim 11 wherein the second multiplexer includes:

a second spreading module coupled to M of the K antenna elements, wherein the second spreading module is configured to receive M of the K received signal replicas and orthogonally spread each of the M received signal replicas with at least one of the N orthogonal sequences so as to be capable of generating a set of M spread signals;

a second summing module coupled to the second spreading module wherein the second summing module is configured to combine the set of M spread signals so as to be capable of generating a second composite signal; and

a second scrambling portion coupled to the second summing module, wherein the second scrambling portion is configured to generate the second set of M channel signals by scrambling the second composite signal.

13. The apparatus of claim 10 wherein the signal recovery module includes
an N channel recovery portion configured to provide N separate signals from the
baseband multiplexed signal, each of the N separate signals corresponding to one of the N
received signal replicas; and

5 an M channel recovery portion coupled to the N channel recovery portion, wherein the M
channel recovery portion is configured to provide M separate signals from the baseband
multiplexed signal, each of the M separate signals corresponding to one of the M received signal
replicas;

wherein the K separate signals include the N separate signals and the M separate signals.

10 14. The apparatus of claim 13 wherein the N channel recovery portion is configured to
provide an interference signal to the M channel recovery portion, wherein the interference signal
is an estimate of interference the first set of N channel signals impart upon the second set of M
channel signals;

15 wherein the M channel recovery portion is configured to subtract the interference signal
from the baseband multiplexed signal before providing the M separate signals.

15 15. The apparatus of claim 13 wherein the M channel recovery portion is configured to
provide an interference signal to the N channel recovery portion, wherein the interference signal
is an estimate of interference the second set of M channel signals impart upon the first set of N
channel signals;

20 wherein the N channel recovery portion is configured to generate N despread baseband
signals from the baseband multiplexed signal and subtract the interference signal from at least
one of the N despread baseband signals before providing the N separate signals.

16. The apparatus of claim 13 wherein the N channel recovery portion includes:

a first despreading module configured to despread the first set of N channel signals so as to be capable of generating N despread baseband signals; and

5 a set of N threshold detectors, wherein each of the N threshold detectors is coupled to the first despreading module so as to receive a corresponding one of the N despread baseband signals, wherein each of the N threshold detectors provides a symbol estimate for a corresponding one of the N separate signals so as to generate N symbol estimates.

17. The apparatus of claim 16 wherein the N channel recovery portion includes:

10 a first resampling portion coupled to the set of N threshold detectors, wherein the first resampling portion is configured to receive the N symbol estimates and spread each of the N symbol estimates according to a corresponding one of the N orthogonal sequences so as to generate a first set of N spread symbol estimates;

15 a first baseband summing portion coupled to the first resampling portion, wherein the first baseband summing portion is configured to combine the N spread symbol estimates so as to be capable of generating a first baseband composite signal; and

a first baseband scrambling portion coupled to the first baseband summing portion, wherein the first baseband scrambling portion is configured to receive the first baseband composite signal and scramble the first baseband composite signal so as to be capable of
20 generating an interference signal;

wherein the interference signal is an estimate of the interference from the first set of N channel signals imparted upon the second set of M channel signals.

18. The apparatus of claim 17 wherein the M channel recovery portion includes:

25 a difference element coupled between the downconversion module and the first baseband scrambling portion, wherein the difference element is configured receive the interference signal from the first baseband scrambling portion and the baseband multiplexed signal from the downconversion module, wherein the difference element is configured to subtract the interference signal from the baseband multiplexed signal so as to be capable of removing
30 interference that the first set of N channel signals imparts upon the second set of M channel signals.

19. The apparatus of claim 10 wherein the signal complies with a communication protocol selected from the group consisting of: orthogonal frequency division multiplexing (OFDM), time division multiple access (TDMA), code division multiple access (CDMA),
5 gaussian minimum shift keying (GMSK), complementary code keying (CCK), quadrature phase shift keying (QPSK), frequency shift keying (FSK), phase shift keying (PSK), and quadrature amplitude modulation (QAM).

20. An apparatus for receiving a signal comprising:

- 10 an antenna array comprising K antenna elements, wherein the K antenna elements are spatially arranged to receive one of a corresponding K replicas of the signal, so as to be capable of generating K received signal replicas;
- a signal processing chain;
- means for processing each of the K received signal replicas using one of N orthogonal
15 sequences, so as to thereby generate K processed signal replicas, wherein N is less than K
- means for orthogonally multiplexing the K processed received signal replicas into a multiplexed signal provided to the signal processing chain;
- means for downconverting, within the signal processing chain, the multiplexed signal into a baseband multiplexed signal; and
- 20 means for transforming the baseband multiplexed signal into K separate signals wherein each of the K separate signals corresponds to one of the K replicas of the signal.

21. The apparatus of claim 20 wherein the means for processing includes:

means for assigning each of N of the K received signal replicas a corresponding one of the N orthogonal sequences so as to be capable of generating a first composite signal;

means for scrambling the first composite signal according to a first scrambling sequence
5 so as to be capable of generating a first set of N channel signals;

means for assigning each of M of the K received signal replicas a corresponding one of M orthogonal sequences so as to be capable of generating a second composite signal, wherein the M orthogonal sequences are a subset of the N orthogonal sequences;

means for scrambling the second composite signal according to a second scrambling
10 sequence so as to be capable of generating a second set of M channel signals; and

means for combining the first set of N channel signals and the second set of M channel signals so as to be capable of generating the multiplexed signal.

22. The apparatus of claim 21 wherein the means for transforming includes:

15 means for removing interference due to the first set of N channel signals from the second set of M channel signals so as to thereby generate M interference-reduced signals comprising a subset of the K separate signals.

23. The apparatus of claim 22 wherein the means for transforming includes:

20 means for removing interference due to the second set of M channel signals from the first set of N channel signals so as to thereby generate N interference-reduced signals comprising a subset of the K separate signals

24. The apparatus of claim 22 wherein the means for removing includes:

25 means for despreading the first set of N channel signals so as to be capable of generating a set of N despread baseband signals;

means for synthesizing an interference signal as a function of the set of N despread baseband signals; and

means for subtracting the interference signal from the baseband multiplexed signal so as
30 to be capable of removing interference due to the first set of N channel signals from the second set of M channel signals.

25. The apparatus of claim 24 wherein the means for synthesizing includes:
means for generating an estimated set of N symbol values for the first set of N channel signals as a function of the N despread baseband signals;

5 means for spreading each of the N symbol values according to a corresponding one of the N orthogonal sequences so as to be capable of generating a first baseband composite signal; and
means for scrambling the first baseband composite signal according to the first scrambling sequence so as to be capable of synthesizing the interference signal.

10 26. The apparatus of claim 23 wherein the means for removing includes:
means for despread the first set of N channel signals so as to be capable of generating a set of N despread baseband signals;

means for despread the second set of M channels signals so as to be capable of generating a set of M despread baseband signals;

15 means for synthesizing an interference signal as a function of the M despread baseband signals; and

means for subtracting, from each of the N despread baseband signals, the interference signal so as to be capable of removing interference due to the second set of M channel signals from the first set of N channel signals.

20 27. The apparatus of claim 26 wherein the means for synthesizing the interference signal includes means for generating estimated symbol values from the M despread baseband signals wherein the means for synthesizing the interference signal includes means for synthesizing the interference signal as a function of the estimated symbol values.

25 28. The apparatus of claim 20 wherein the signal complies with a communication protocol selected from the group consisting of: orthogonal frequency division multiplexing (OFDM), time division multiple access (TDMA), code division multiple access (CDMA), gaussian minimum shift keying (GMSK), complementary code keying (CCK), quadrature phase shift keying (QPSK), frequency shift keying (FSK), phase shift keying (PSK), and quadrature amplitude modulation (QAM).

30

29. A method for multiplexing K channels on to a receiver chain, the K channels including N channels corresponding to N antenna elements and M channels corresponding to M antenna elements, the method comprising:

5 spreading each of the N channels according to a corresponding one of N orthogonal sequences so as to form N spread channels;

 overlaying a first scrambling sequence on to the N spread channels so as to form a first set of N channels;

 spreading each of the M channels according to one of the N orthogonal sequences so as to
10 form M spread channels;

 overlaying a second scrambling sequence on to the M spread channels so as to form a second set of M channels;

 combining the first set of N channels and the second set of M channels so as to form K multiplexed channels; and

15 providing the K multiplexed channels to the receiver chain.

30. A method for separating K symbol streams, each of the K symbol streams being conveyed by K respective orthogonally spread channels in a receiver chain, the K channels including a first set of N channels and a second set of M channels, each of the N channels being spread according to a corresponding one of N orthogonal sequences and each of the M channels being spread according to one of the N orthogonal sequences, the method comprising:

- despreading the first set of N channels so as to generate N separate channels;
- detecting, from the N separate channels, a set of N symbols wherein each of the N symbols is conveyed by a corresponding one of the N channels;
- generating a first interference signal due to the first set of N channels based upon the set of N symbols;
- subtracting the interference signal from the second set of M channels;
- despreading the second set of M channels so as to generate M separate channels;
- detecting, from the M separate channels, a set of M symbols wherein each of the M symbols is conveyed by a corresponding one of the M channels; and
- providing K separate symbols wherein the K separate symbols include the set of N symbols and the set of M symbols.

31. A method for receiving a signal with an antenna array comprising:

- receiving K replicas of the signal, each of the K replicas being received by one of a corresponding K antenna elements of the antenna array, wherein the K replicas include N replicas and M other replicas of the received signal;
- multiplexing the N replicas and the M replicas of the signal into a multiplexed signal provided to a single processing chain;
- removing interference due to the N signals from the multiplexed signal;
- demultiplexing, after the interference due to the N signals is removed, the M signals from the multiplexed signal, thereby generating M detected signals;
- removing interference due to the M signals from the multiplexed signal;
- demultiplexing, after the interference due to the M signals is removed, the N signals from the multiplexed signal, thereby generating N detected signals.